Calibration, Characterization and first Results with the Ocean PHILLS Hyperspectral Imager

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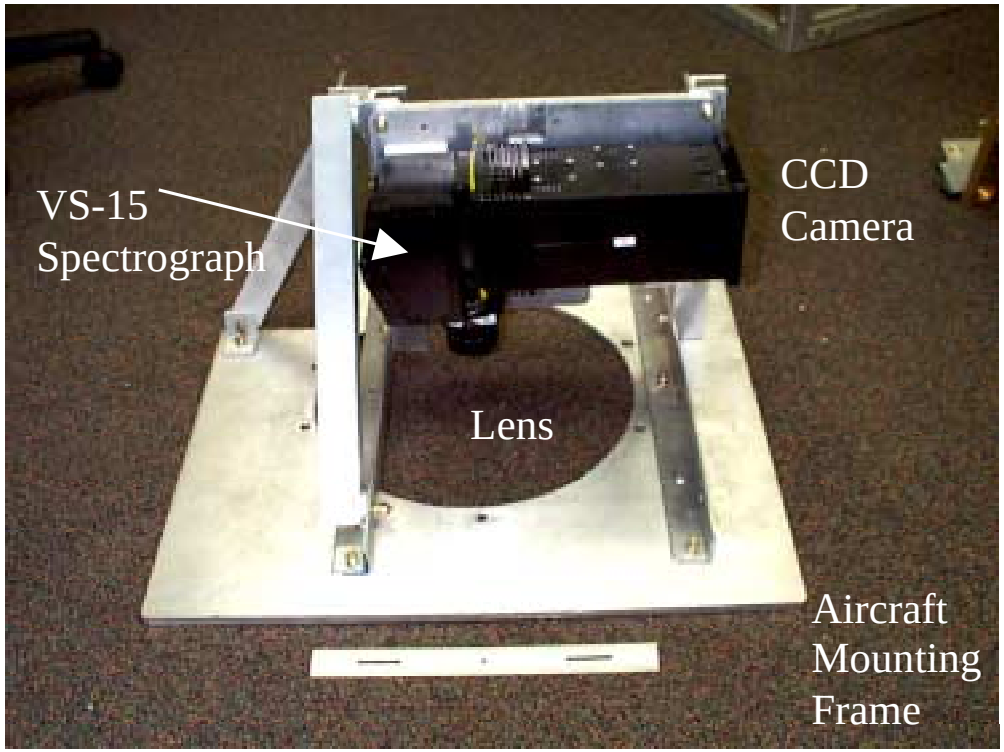
Presentation outline

- **Goals:**
  - **To develop, calibrate and test the Ocean PHILLS, a new hyperspectral imager specifically designed for imaging the coastal ocean**
  - **To test the performance of the Ocean PHILLS during the CoBOP field experiment at Lee Stocking Island in the Bahamas**

- **Outline:**
  - **The Ocean PHILLS hyperspectral imager**
  - **Characterization and calibration**
  - **Example Images from Lee Stocking Island**
  - **Summary and future work**

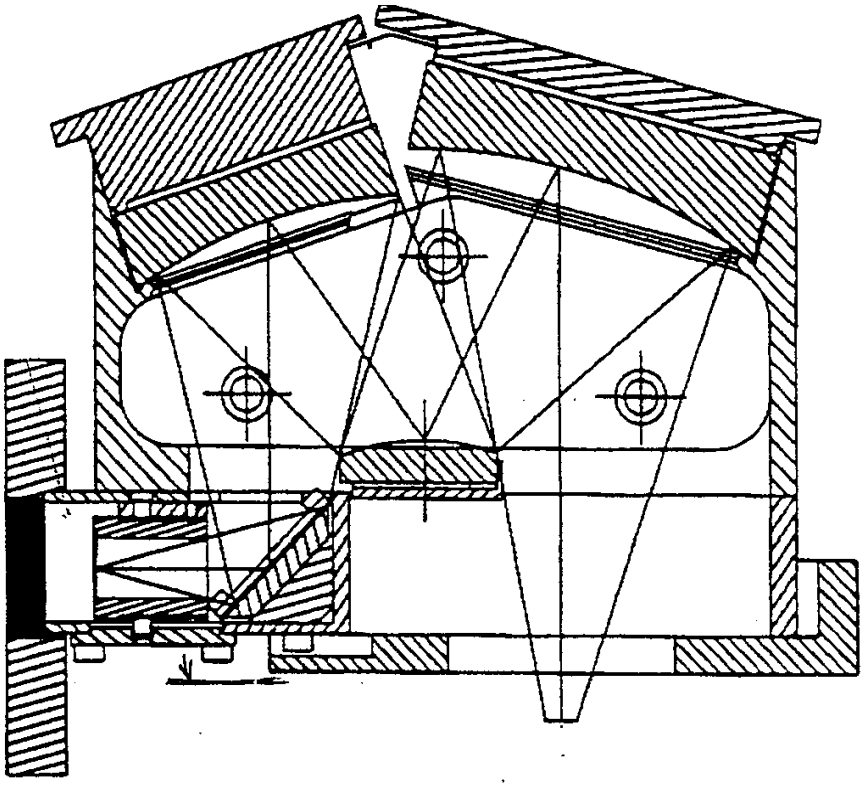
Ocean Portable Hyperspectral Imager for Low-Light Spectroscopy (Ocean PHILLS)



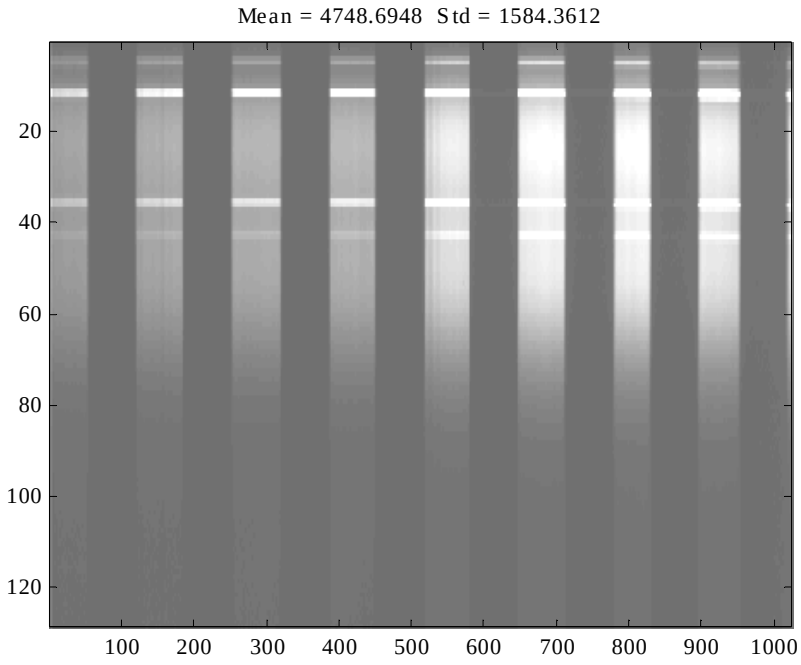
- **Ocean PHILLS is a push-broom imager**
- **f 1.4 high quality video camera lens with a 30 degree field of view as the fore optic**
- **all reflective spectrograph with a convex grating in an Offner configuration to produce a distortion free image (Now available through American Holographic, Fitchburg, MA)**
- **1024 x 1024 thinned backside illuminated CCD camera (Pixel Vision, Inc, Beaverton, OR)**
- **Images 1000 pixels cross track and is typically flown at 3000 m altitude yielding 1.5 m GSD and a 1500 m wide sample swath.**
- **The data is captured with a frame grabber in a high performance windows-NT computer with a 27 GB RAID storage system**

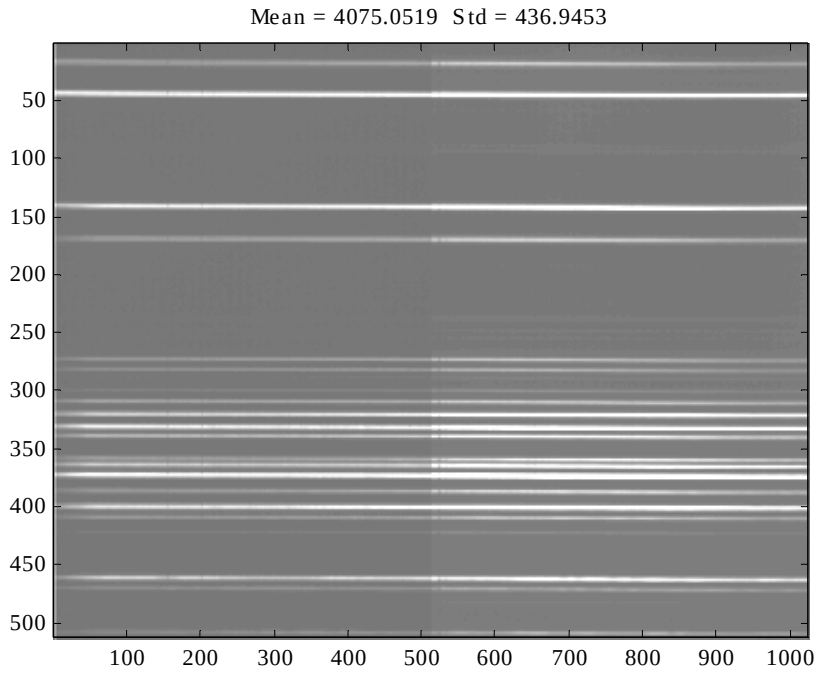
The HyperSpec™ VS-15 Spectrograph

HyperSpec VS-15 Specifications	
size	65 x 80 x 100 mm
weight	24 oz (w/o camera or lens)
Field Size	12 mm
Dispersion	400 – 1000 nm over 12 mm
Aperature	f/2
Spot Size	<12 microns rms
Keystone Distortion	<0.1%
Smile Distortion	<0.1%
Stray Light	<0.001%
Polarization	<5%



Calibration Images and Geometric Performance



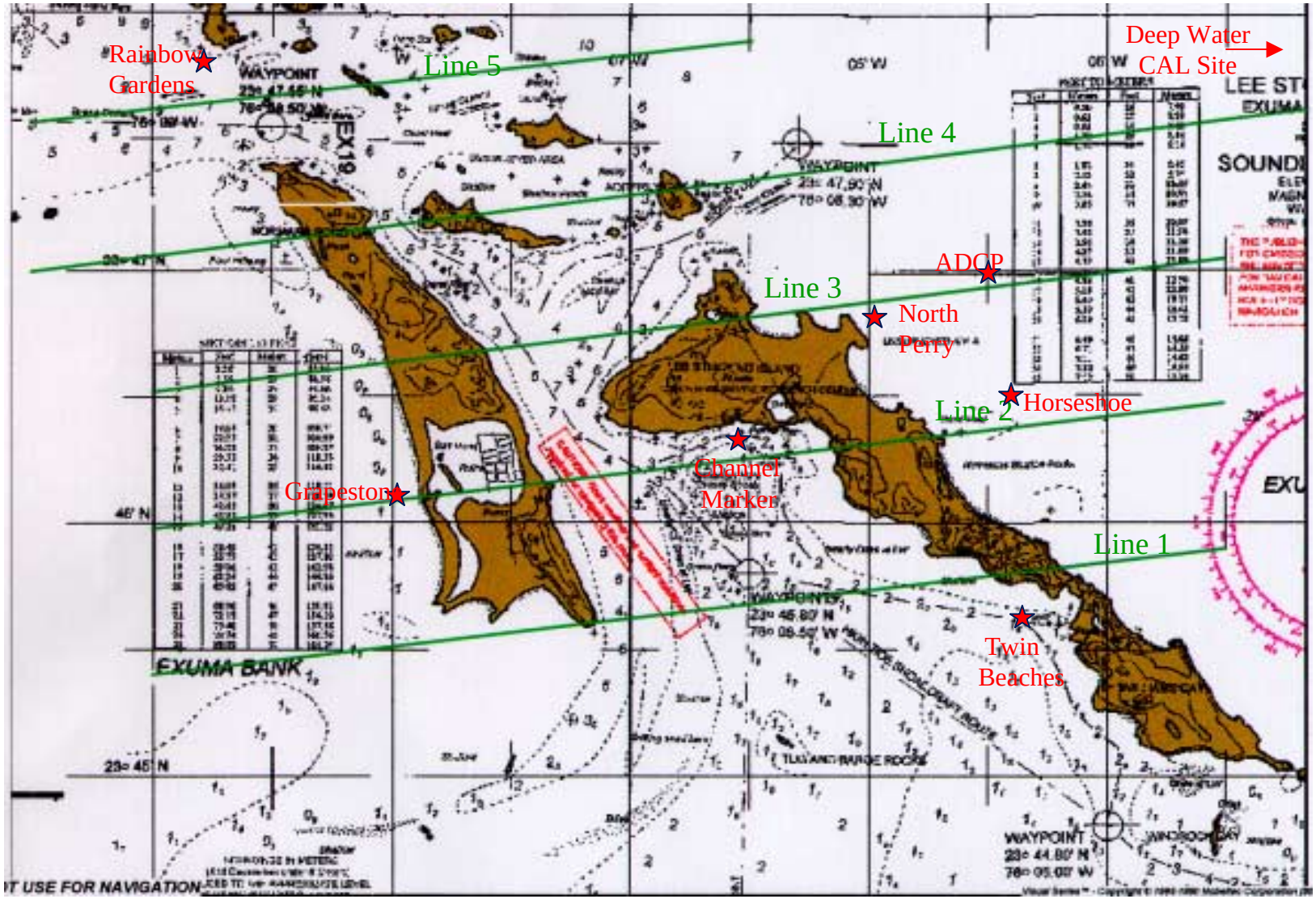


Performance Metric at f/4	Value
RMS Spot size (spatial direction)	2 pixels (24 microns)
RMS Spot size (spectral direction)	2 unbinned pixels (24 microns)
Keystone Distortion	< 1 pixel
Smile Distortion	< 1 pixel
Rotation (center to edge)	1 unbinned pixel

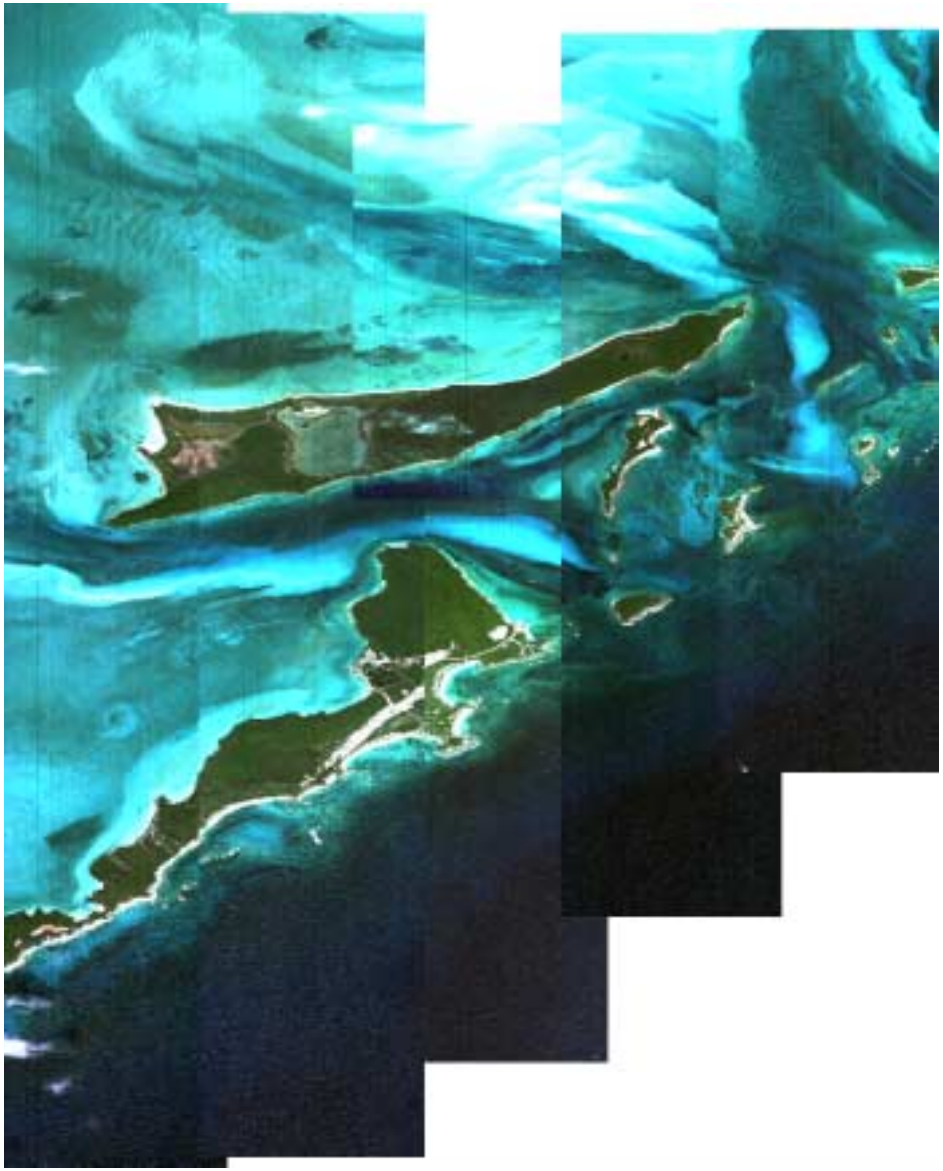
The Antonov AN-2 (Annie)

- Soviet Designed and Polish built.
- Worlds largest production biplane.
- Operated by Bosch Aerospace, Inc.
- Nominally data was collected at 3000 m at 90 knots.
- Slow, steady and reliable.

Lee Stocking Island Flight Lines



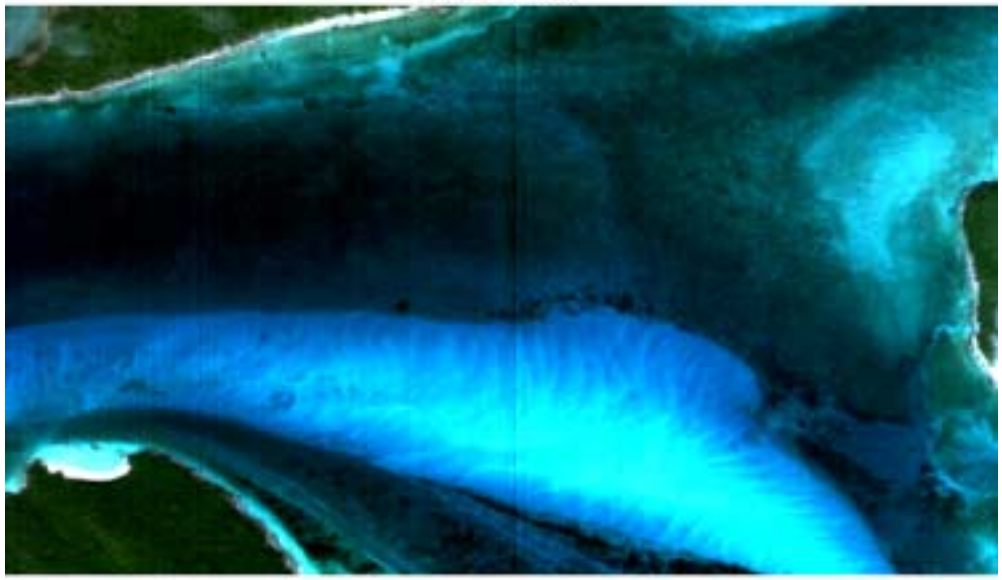
Mosaic of Bahamas Study Area



Lee Stocking Island
and Norman's Pond Cay
1 June, 1999, 9:00 - 10:00 am
NRL Ocean PHILLS
hyperspectral data shown as
true Color RGB image

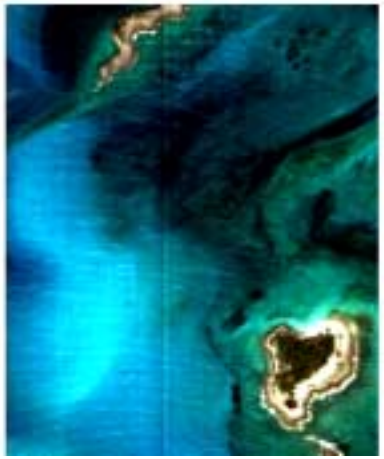
Details of Study Areas

Adderly Cut



Twin Beaches

Rainbow Gardens



1.5 m GSD Ocean PHILLS data resolves, sand waves, grass beds and coral heads in this complex environment.

Summary

- These first results with the Ocean PHILLS hyperspectral imager are promising:
  - Adequate SNR and sensitivity for ocean imaging,
  - HyperSpec™ VS-15 Spectrograph appears to meet design requirements,
  - Minor alignment adjustments could improve already good spectral alignment and spot size.
- Valuable data set collected during the Lee Stocking Island experiment.
  - Large team of scientists beginning to exploit this data set
- Future work:
  - Redesign camera to spectrograph mount to improve alignment.
  - Major focus on data processing and ocean algorithm development.